Salter enumerates amongst others the following American species in the Durness Limestone; some of which, however, are too imperfect for accurate identification:—

Orthis striatula, Emmons [non Schlotheim].
Ophileta compacta, Salter.
Maclurea matutina ? Hall.
Orthoceras arcuoliratum, Hall.
——— *undulostriatum*, Hall.
——— *vertebrale* ? Hall [very doubtful].

In addition to these, there are among the fossils I received from the Geological Survey of Scotland, specimens of *Endoceras* in a very fragmentary condition, but resembling certain small (?) species with very closely approximate septa, described and figured by Billings from the Calciferous group of Canada.[1]

A *Cyrtoceras*, very probably the *Oncoceras* ? referred to by Salter, is also in a condition unfit for determination.

Though the Durness fossils are by no means well preserved, yet it can hardly be disputed that their general facies, as Salter affirmed, is American rather than European. The testimony of the fossils, so far as it goes, is supported by that of the rocks, for we learn from Mr. Peach[2] that in the order of succession of the beds in the North-west Highlands of Scotland an almost exact counterpart is presented of the strata "exposed along the axis of older Palæozoic rocks, stretching from Canada through the Eastern States of North America."

"In the latter region," continues Mr. Peach, "the Silurian strata of Sutherlandshire are represented by (1) the Potsdam Sandstone, always described as being vertically piped by *Scolithus*, like the "pipe-rock"; (2) the Calciferous group; and (3) part of the Trenton Limestone.

He further argues, that the beds in these widely-separated areas, though probably not contemporaneous, were homotaxial, and he supposes that the species migrated from one province to the other "along some old shore-line or shallow sea," some barrier separating them from Wales and Central Europe.

IV.—Woodwardian Museum Notes: on some Anglesey Dykes. II.

By Alfred Harker, M.A., F.G.S.,
Fellow of St. John's College.

IN the northern half of Anglesey occur several intrusions of dark hornblendic rocks, some specimens of which were placed by Henslow in the collection made by him for the Woodwardian Museum. These rocks present a type unusual in Britain, and show some peculiarities which are of considerable interest.

A few years ago Professor Bonney found on the south-west coast of the island some boulders of a rock which he described[3] under the

[1] Canadian Naturalist, 1859, vol. iv. p. 361.
[2] Presidential Address before the Royal Physical Society of Edinburgh, Nov. 1885.
[3] Q. J. G. S. vol. xxxvii. p. 137, 1881: vol. xxxix. p. 254, 1883: vol. xli. p. 515, 1885. See also Teall, "British Petrography," pp. 81, 82; plates iv. and vi. 1886.

name of Hornblende-picrite. It was subsequently pointed out by Professor Hughes that the probable source of these rocks was to be found in certain intrusive masses near Llanerchymedd, and indeed such boulders are scattered about rather abundantly in that neighbourhood and to the south-west. The rock in question seems, however, to be the common type of the larger eruptive masses in the north of Anglesey, and brief notes on slides cut from selected specimens taken in place may be found not unprofitable. The rocks were noticed and megascopically described in Henslow's Memoir.[1]

There are three localities in each of which similar varieties occur. The first lies to the north and north-east of the town of Llanerchymedd, where the map of the Geological Survey shows nine intrusions. These masses, not properly dykes, have an oval or elongated form, with lengths of from 200 yards to three-quarters of a mile, their long axes running generally with the strike of the adjacent strata. These beds, Arenig according to Professor Hughes,[2] are baked at the junction, but not extensively altered. On Henslow's map no attempt is made to separate the several patches, which are marked as one area of "greenstone." I have collected specimens from the six masses lying between Rhodogeidio and Llandyfrydog, but am not able to state whether the three patches to the north of the latter place are of similar characters.

A large irregularly-shaped mass appears on the western slope of Llaneilian Mountain, in the north-eastern corner of Anglesey. This has been mentioned by Professor Hughes and examined microscopically by Professor Bonney. It too pierces rocks probably of Arenig age, as well as the debatable Amlwch series. Our specimens are from Pengorphwysfa.

The third area is situated to the east of Llanbabo, among the alluvial deposits of the River Alaw. The exposures here are, according to Henslow, "not well exhibited," and they have escaped the notice of the Survey; but the locality is verified by Professor Hughes, who obtained a similar rock from south-west of Glas-grug.

Rocks having many points in common with these occur as parts of some large dykes in Holyhead Island; but they will be more conveniently considered apart, and our present description will apply only to the three groups of intrusive masses mentioned above. The specimens are selected as follows:—

I. Hafod-in-in dyke (A 130, 131);
Rhodogeidio dyke (A 132);
Llys Einion dyke (A 86, 91, 94, 134, and Hughes Coll. 33);
Maen Chwynt dyke, probably (Sedg. Coll. 37);
Llandyfrydog dyke (Henslow [695]);

II. Llaneilian Mountain intrusive mass (A 35, 37, and Hughes Coll. two slides), all from Pengorphwysfa near Amlwch; also Henslow [715];

III. Dykes or masses east of Llanbabo (Henslow [711, 712]).

Besides these, a large number of hand-specimens from all the localities have been examined.

[1] Trans. Phil. Soc. Camb. vol. i. 1822. [2] Q. J. G. S. vol. xxxviii. p. 26, 1882.

The constituent minerals of these rocks are apatite, ilmenite, pyrites, magnetite, olivine, felspar, augite, hornblende, and biotite; besides leucoxene, serpentine, calcite, quartz, chlorite, epidote, and other secondary products.

Apatite is often abundant in slender prisms, and seems to be always the earliest formed constituent.

Iron-ores are almost always among the original minerals, and sometimes magnetite and ilmenite are recognizable in the same slide. Ilmenite when best developed shows in skeletons of intersecting rods choked with grey leucoxene; in other places the presence of a titaniferous mineral can only be inferred from these cloudy grey masses. Magnetite sometimes forms rods, but more usually imperfect cubes. There is also secondary granular magnetite resulting from the alteration of the iron-bearing silicates. In some of the original grains a scarcely perceptible brown translucency may indicate picotite.

Olivine is rarely abundant, and for the most part not detected. Occasionally rounded and oblong patches of serpentine show the characteristic mesh-structure; but the bulk of this substance met with in the slides can be clearly traced to the decomposition of pyroxene and amphibole minerals, and is usually mixed with chlorite. The rocks east of Llanbabo, however, show plenty of olivine.

Felspar of the lime-soda series seems to have been a universal constituent, and locally abundant. In most of the slides this mineral is replaced by calcite, chlorite, and quartz. Where the felspar is fresh enough to exhibit its original characters, it seems from its low extinction-angles to be never a very basic variety: it may be referred, if this test is trustworthy, to andesine and oligoclase. Twin-lamellation on the albite-law is almost always seen, but the pericline twinning rarely. The felspar is usually later than the ilmenite, and earlier than the augite and hornblende, which it penetrates; but in some slides from Llys Einion the felspar partly penetrates and partly moulds the hornblende.

Augite is not always present, but it is probable that this mineral has been essential in all these rocks, and has been in great part replaced by hornblende. In some slides from the Llys Einion and Llanbabo dykes the process of conversion can be traced. The two minerals have the orthopinacoids and the clinopinacoids parallel: they are most intimately associated, with an extremely irregular line of division, and the augite often remains as a core surrounded by brown hornblende.

Hornblende is the most abundant mineral in these rocks, and occurs in several distinct varieties. It is the prevalence of one or other of these varieties, as much as any essential diversity of constitution in the rocks, that gives rise to the difference of aspect observable in hand-specimens.

Original hornblende is found in well-formed crystals, usually from one-eighth to half an inch in length. The terminal planes are probably in most cases the usual (011) and ($\bar{1}$01), but the basal plane also occurs (001), and a very oblique one which may be ($\bar{2}$01).

The cross-section always shows the prism form (110) well developed, often truncated by the clinopinacoid (010), and sometimes the orthopinacoid (100). Twinning on the usual law is common. The prismatic cleavages are well-developed, and rarely the clinopinacoidal cleavage is nearly as well marked. The colour is usually brown, with strong pleochroism, vibrations parallel to the axes of elasticity giving: γ, deep chestnut brown; β, a less deep brown; α, a pale brown. The absorption is then $\gamma > \beta >> \alpha$; more rarely it is $\gamma = \beta >> \alpha$. Sometimes, however, this original hornblende is brownish-green, the vibrations parallel to the γ-axis giving a pale grass-green, and perpendicular to it a very pale brown. The larger crystals occasionally present a mode of alteration different from the ordinary chloritic and serpentinous changes, and consisting sometimes of a brown coloration, sometimes a decoloration and decomposition into a granular substance. These alterations affect the hornblende along certain planes, which are not parallel to the prismatic cleavage, but to the clinopinacoid, and are perhaps to be regarded as "solution-planes" (*Lösungsflächen*).

Another kind of hornblende, probably also original in the usual sense, is often present in the dykes to the north of Llanerchymedd. A cross-section of a brown hornblende crystal is seen, showing the prism and clinopinacoid faces, but upon the latter a later accretion of green hornblende-substance, in crystalline continuity with the brown, has reduced or entirely built over the clinopinacoids, extending the prism-planes at their expense. From its relation to surrounding minerals and from its always presenting definite crystal boundaries, this later growth of green hornblende seems to have originated before the final consolidation of the rock.

Next comes the hornblende resulting from the alteration of original augite. The "paramorphic" origin of hornblende from pyroxenic minerals has received so much notice in recent years, that there is no need to enlarge upon it here, further than to remark that the term "paramorphism" is strictly applicable only when the two minerals yield identical analyses, which is probably an unusual case. In the present instance it is most likely that some chemical as well as physical change is involved. The hornblende thus produced is brown, compact, and well-cleaved: in fact a study of the Anglesey dykes, as well as rocks from several localities in Carnarvonshire, bears out the conclusion of Lossen and others, that neither colour nor structure affords any reliable criterion for discriminating between original hornblende and that resulting from the amphibolisation of augite. It is possible that some of the hornblende may be derived from a rhombic pyroxene, and indeed the slides from the rocks east of Llanbabo have a mineral resembling altered enstatite. Professor Bonney has noticed the same in the Llys Einion dyke and boulders.

Some slides (*e.g.* from the Hafod-in-in dyke) contain a considerable quantity of a rather pale, dull, brownish-green or greenish-brown hornblende without crystal boundaries. Compared with the foregoing varieties, it is seen to be less clear and less strongly coloured, to give lower polarisation-tints, and to have its cleavage-

traces often less pronounced. It is later than the original brown hornblende, which it includes. It also includes augite, without any definite crystallographic relation to it, and so is probably not 'paramorphic.' On the whole, it seems likely that this dull-coloured hornblende is a secondary growth posterior in date to the consolidation of the rock, though this cannot be regarded with certainty, as in the following case.

Lastly, we have hornblende, sometimes green, but more commonly colourless, forming a sharply-defined border to original hornblende crystals, and filling the interstices between them. A study of the slides leaves no doubt that this new growth of hornblende-substance has taken place subsequently to the consolidation of the rock. In some cases it can be verified that the new hornblende extends into the space formerly occupied by felspar crystals. Again, the interspace between two or three original or paramorphic hornblendes is found to be filled by colourless substance, which between crossed Nicols breaks up into distinct portions in crystalline continuity with the several adjacent crystals. This is exactly analogous to the cement of secondary quartz observed by Dr. Sorby and others between the grains of certain quartzites. Sometimes a well-bounded original crystal has a sharply-defined border of greener hornblende, and outside this a margin of colourless hornblende-substance with ragged outline abutting upon patches of calcite dust, etc., which probably represent destroyed felspar. In such a case the double border is all in crystalline continuity with the original crystal. The secondary hornblende here described gives rather higher polarisation-tints and a slightly wider extinction angle than the other varieties of the mineral.

Mr. Van Hise, who was the first to notice the "secondary enlargement of hornblende fragments" in conglomerates, has recently described[1] a like phenomenon in altered diabases from Michigan and Wisconsin, and he cites similar results arrived at by Becke[2] in 1883. I am not aware that this secondary growth of hornblende on the margins of pre-existing crystals has been recognized in British rocks, although Prof. Bonney, referring to the rocks now under discussion, has remarked on the sudden transition from dark brown to almost colourless hornblende, and has figured a very characteristic case in a similar rock from Little Knott in Cumberland.[3] The Rhodogeidio and Llys Einion dykes furnish the best examples.

The only remaining mineral that calls for special notice is the brown mica, which has been mentioned above as biotite, although its characters are not easy to make out very definitely. It is not abundant except in some specimens from Llandyfrydog, which have to the eye almost a lamprophyric aspect. In his specimen [695] especially Henslow remarks the presence of "small shining plates, apparently diallage." These are the flakes of mica, and their peculiar lustre is explained on examination under the microscope.

[1] Amer. Journ. Sci. May, 1887, 3rd ser. vol. xxxiii. p. 385.
[2] Tscherm. Min. u. Petr. Mitth. vol. v. part ii. 1883.
[3] Q. G. G. S. vol. xli. plate xvi. fig. 2, 1885.

The slide appears at the first glance totally unlike all the others, showing only numerous flakes of mica in a confused mass of decomposition products, without any trace of augite, olivine or hornblende. The mica is less strongly coloured and less pronouncedly dichroic than is usual in biotite, except in the bleached mineral often met with in the lamprophyres and some peridotites. It gives, however, a moderately deep or rather light brown for vibrations parallel to the cleavage-traces, and a paler brown in the direction at right angles to this. The extinctions are sensibly parallel and perpendicular to the traces, and a cleavage-flake is dark between crossed Nicols. The plates are split into thin lamellæ separated by lenticular grains and layers of a colourless, doubly refracting mineral. The interposition of calcite lenses between the foliæ of biotite has been noticed by Zirkel, Hussak, and Williams, but here the mineral is not calcite. Each lenticular grain consists of portions differently oriented, and there is sometimes a radial fibrous appearance suggestive of a zeolitic mineral. The mica includes also a large quantity of granular magnetite. A slide [711] from the Llanbabo mass contains precisely similar flakes of mica, though in much less quantity, and the mineral appears to be closely connected with the brown hornblende, as if resulting from its alteration. This slide probably shows the beginning of a process of which the Llandyfrydog specimen represents the final stage. The secondary production of biotite in place of hornblende is seen also in the Pen-y-rhiwiau and Penarfynydd rocks mentioned below, and in some other Welsh rocks, such as the syenite of Llanfaglen near Carnarvon.

The structural variations of each dyke have not been studied in detail. As Henslow and Professor Hughes have pointed out, the megascopic characters often change largely in a very short distance, though the microscope shows that these variations do not always import any considerable difference in constitution. The more felspathic type of rock sometimes occurs as segregation-veins in the darker and more hornblendic. The dykes grow rather finer-grained at the immediate margin, and these portions are more susceptible to destructive weathering action than the coarser rock. A slide (A 134) from Llys Einion, close to the junction with the shales, shows advanced decomposition; but besides the calcite, 'viridite,' etc., there remains an abundance of felspar in good crystals, and partly bleached brown hornblende in crystals and ophitic plates, the latter bordered by colourless fringes of the usual secondary growth.

The coarse black type of rock, with its cement of secondary hornblende, is very durable, and, as has been remarked, the erratics are mainly of this variety. The dykes themselves form prominent features in the country, which doubtless led Henslow to map the whole district north of Llanerchymedd as consisting of these rocks. The smaller dolerite dykes of southern Anglesey, on the other hand, make but little show at the surface, and are difficult to find; a fact indicated on the Survey Map, where the greater part of the dykes marked are on the sea-shore.

The affinities of the rocks described above have been discussed by Prof. Bonney, who points out their close resemblance to that of Pen-y-rhiwiau near Clynnog-fawr, Carnarvonshire, and the so-called Diorite of Little Knott in Cumberland. With the latter I am not acquainted, but a number of slides cut from selected specimens of the Pen-y-rhiwiau mass show the closest resemblance to these Anglesey dykes, especially those of Rhodogeidio, Llys Einion and Hafod-in-in. There are the same minerals associated in the same manner,[1] the amphibolisation of the augite, the secondary marginal growth of colourless amphibole, and the apparent conversion of the brown hornblende into biotite being all well exhibited. There is more olivine than in the Anglesey 'dykes,' although this constituent is variable in amount, and a few other differences are to be noted; but the rocks may well be classed together. Bearing in mind the comparatively small quantity of olivine found, the constant presence of felspar, and that not of a basic variety, the common occurrence of original iron-ores, and the general structure of the rocks, they seem to find their most natural place among the olivine-bearing hornblende-diabases, rather than with rocks of ultrabasic type.

The mode of occurrence of these masses is different from that of the beautiful hornblende-picrite of Penarfynydd, which forms a massive bank 200 or 300 feet in thickness, and of very uniform character. It is worthy of note that the intrusions of Llys Einion and Llaneilian Mountain, as well as Penarfynydd, occur in Arenig strata, and the slates at Pen-y-rhiwiau are referred to the same age: I do not know with what degree of probability the Skiddaw slates of Little Knott can be assigned to the Arenig also.

V.—Two New French Meteorites.

Preliminary Notice by James R. Gregory.

TWO Meteorites from France have recently come into my possession from a private source, one of which, though not of a recent fall (1836), has neither been described nor chemically examined, and which I now briefly bring to notice, it being of a most rare type. The other is of a much more recent fall (1875), and is of a much more ordinary character, being similar to many other meteorites of the same class; this stone also appears not to have been described, nor has any notice of it been published. It is somewhat a remarkable coincidence that these two stones should have fallen in the same Department, although at such widely different dates, and from the data and notes I have received from careful inquiries, I now bring forward the following details of these two aerolites.

I. Aubres, Commune of the Canton of Nyons (Drôme), France.

This meteoric stone fell on September 14, 1836, at 3 p.m., in calm weather and blue sky, at Aubres, Commune of the Canton of Nyons, in the department of Drôme, France. It fell on a hard and pebbly

[1] The resemblance even extends to the 'solution-planes' in the brown hornblende, parallel to the clinopinacoid (010). The slides from Pen-y-rhiwiau, however, contain an abundance of pale grass-green actinolite in blades and fan-shaped bundles.